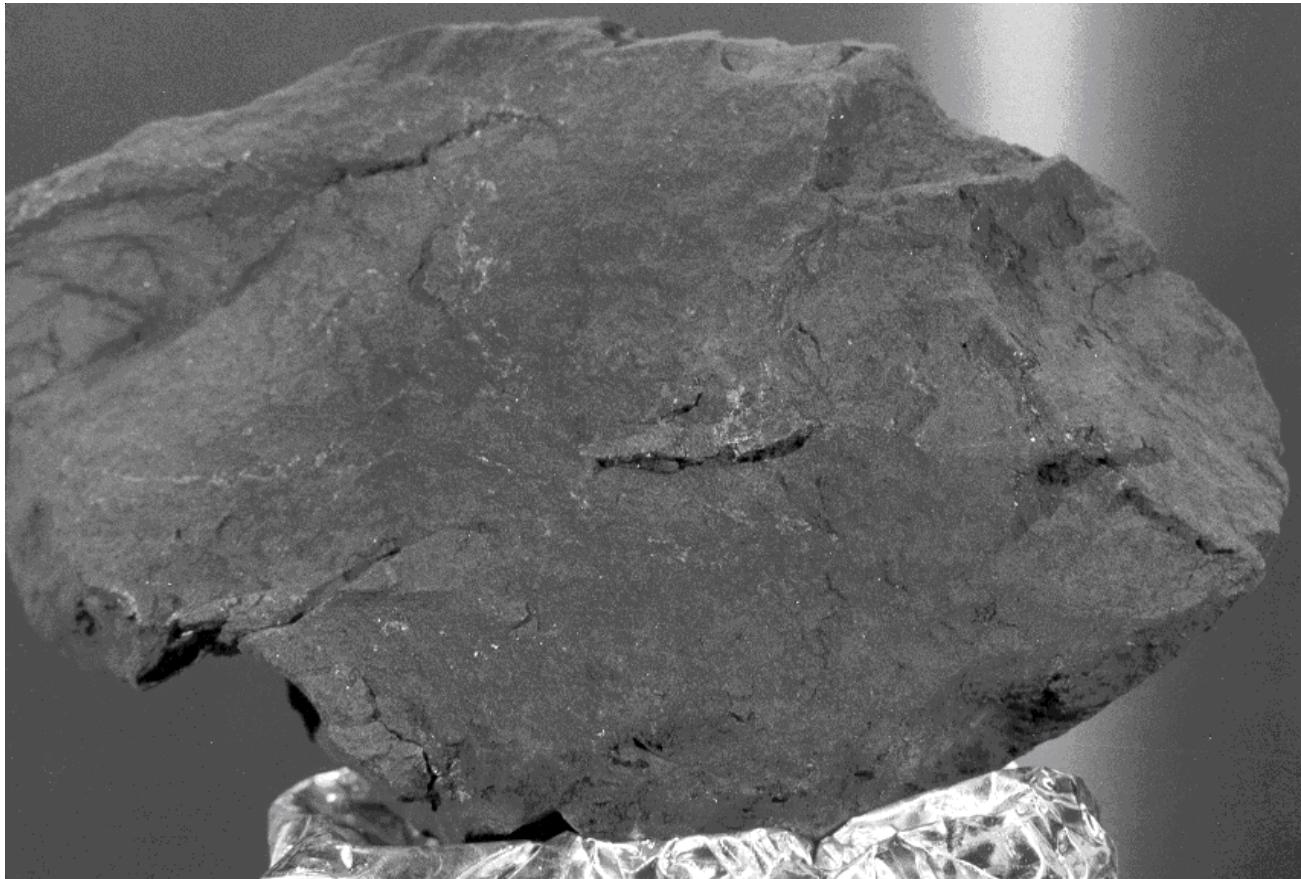


**10048**

Regolith Breccia  
579 grams

*DRAFT*



*Figure 1: Photo of 10048 before breaking. Sample is 13 cm, end-to-end. NASA S69-45678.*

### **Introduction**

McKay et al. (1970), McKay and Morrison (1971), Fruland (1983) and Simon et al. (1984) reported that 10048 is very similar to the Apollo 11 soil in its character. It is a glass matrix breccia derived from the soil by impact, containing a lot of solar wind elements.

There are small clasts of mare basalt in the matrix along with dark orange to red glass beads (~100 microns) in 10048.

### **Petrography**

Schmitt et al. (1970) reported the bulk density as 2.45 g/cm<sup>3</sup>. Phinney et al. (1976) describe 10048 as a coherent, vitric microbreccia with about 50 % glass in the matrix. Simon et al. (1984) included breccia 10048 in their comprehensive study of Apollo 11 regolith breccias – their mode is given in the table. They calculated that it had about 25% highland component, but couldn't directly identify that many clasts of highland rock.

### **Simon's Mode**

	<b>S</b>	<b>L</b>
Mare Basalt	4.3	12.4
Highland Component	0.4	0.3
Regolith breccia	3.7	0.1
Agglutinate	5.8	3.7
Pyroxene	4.7	0.4
Olivine	0.1	
Plagioclase	3.7	0.2
Ilmenite	2.8	
Orange glass	2.7	0.2
Other glass	3.1	0.3
Matrix	50.1%	

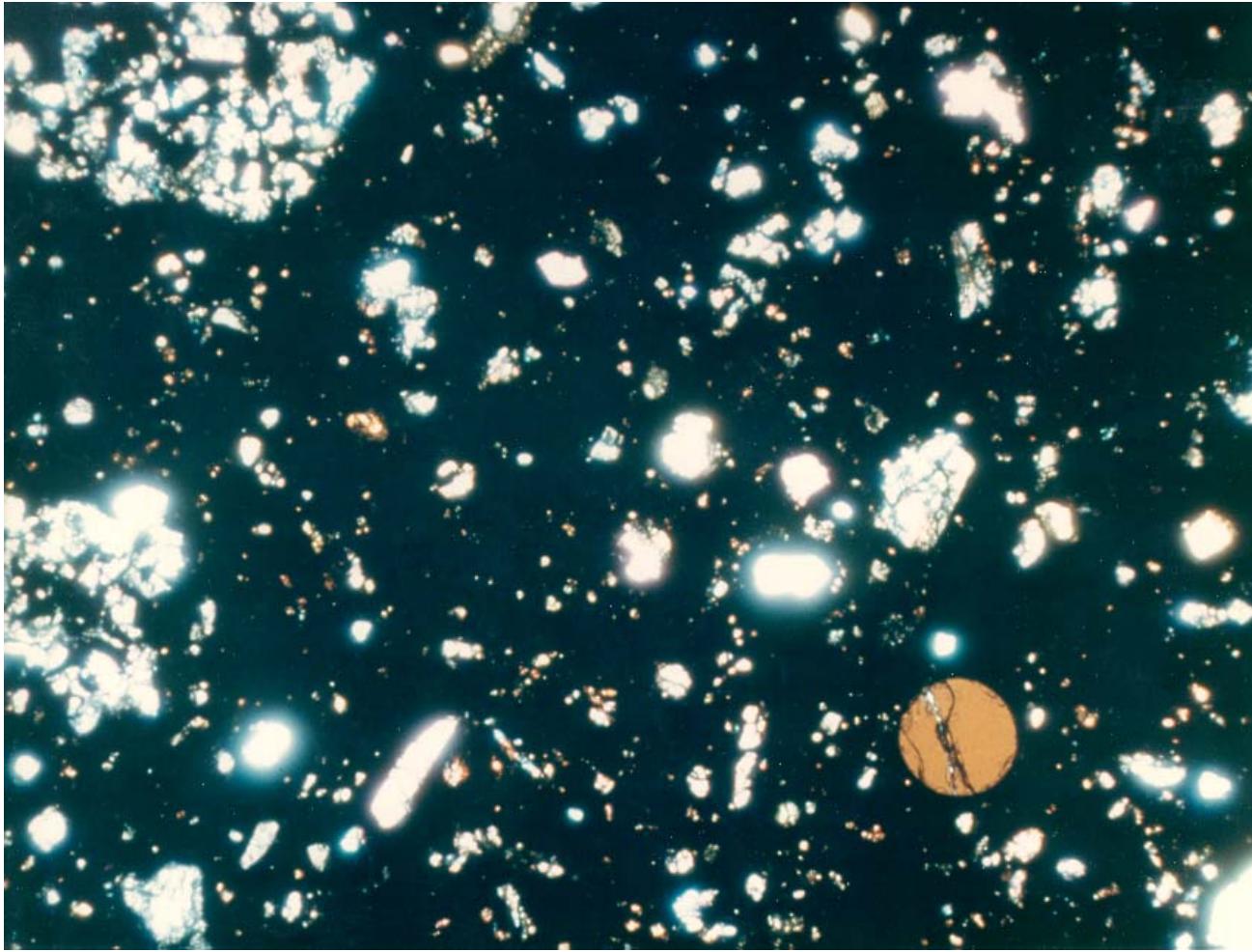


Figure 2: Transmitted light photomicrograph of thin section 10048,33 showing orange glass bead and basalt fragments in ultrafine matrix. Scale is 2.5 mm. NASA S70-49472.

### **Chemistry**

Rose et al. (1970), Goles et al. (1970) and Rhodes et al. (1981) reported the major element composition of 10048 (table 1). Haskin et al. (1970), Goles et al. (1970), Ganapathy et al. (1970), Wasson et al (1970) and Wiesmann and Hubbard (1976) reported trace element content.

Thiemens and Clayton (1980) determined 119 ppm nitrogen (with a very negative delta  $^{15}\text{N}$ ).

Simon et al. (1984) calculate that 10048 is made up of about 75% local mare basalt and about 25% highland component.

### **Radiogenic age dating**

none

### **Cosmogenic isotopes and exposure ages**

None

### **Other Studies**

The total organic carbon content of 10048 was determined by hydrogen flame ionization pyrolysis (Ponnampерuma et al. 1970). Filleux et al. (1978) studied the carbon on the surface and the interior of 10048 (figure 7).

Funkhauser et al. (1970) and Hintenberger et al. (1975) determined rare gas abundance and isotopic ratios (figure 5).

Dunn and Fuller (1972) and Nagata et al. (1971, 1972) determined magnetic properties. Schwerer et al. (1972) determined the Mossbauer spectra and magnetic susceptibility.

### **Processing**

Apollo 11 samples were originally described and cataloged in 1969 and “re-cataloged” by Kramer et al. (1977). Pieces of 10048 were used for public displays



Figure 3: Photo of 10048,49. Sample is 5 cm across. NASA S76-26847.

in 1969-71, until more favorable samples were available (figure ). Portions of 10048 were added to the “biopool” sample used to check for pathogens and life forms during Apollo 11 quarantine.

Saw cuts (wire saw) can be seen in some of the photos of 10048.

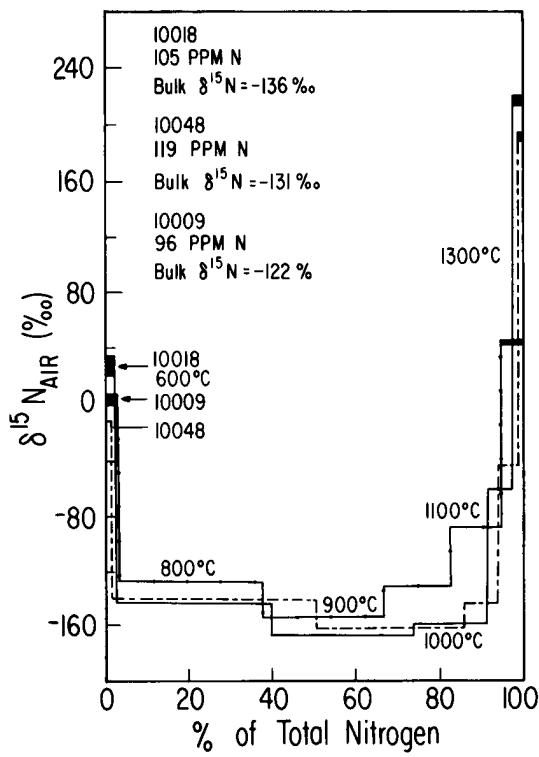


Figure 6: Thermal release pattern for nitrogen isotopes from 10048 and other samples (Thiemens and Clayton 1980).

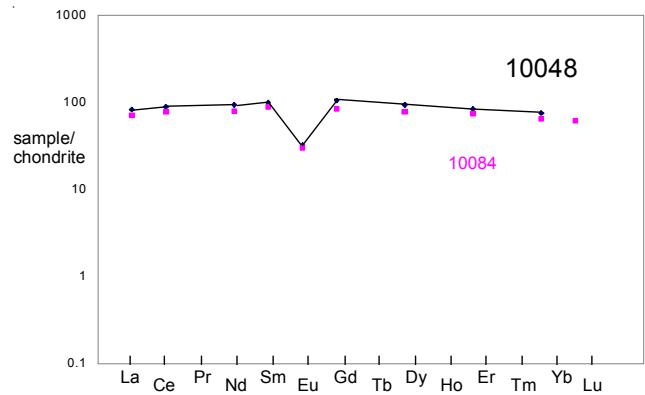


Figure 4: Normalized rare earth element diagram for breccia 10048 compared with soil 10084 (data from Wiesmann et al. 1975).

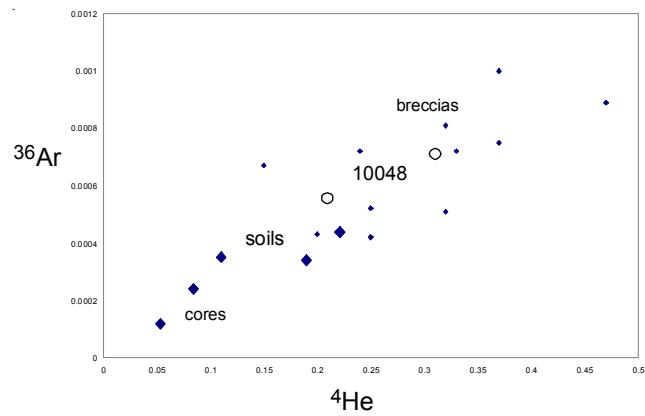


Figure 5: Implanted solar wind in 10048 compared with Apollo 11 soils and breccias (Funkhouser et al. 1970 and Hintenberger et al. 1976). Units STP cc/g.

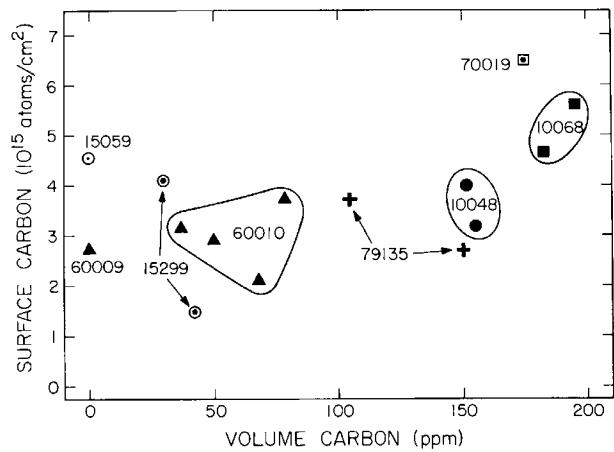


Figure 7: Measured surface and volume concentrations of carbon for regolith samples from several missions (Filleau et al. 1978).

**Table 1. Chemical composition of 10048.**

reference weight	Wiesmann75	Haskin70	Goles70	Rhodes81	Ganapathy70	Wasson70	Rose70
SiO <sub>2</sub> %			38.7	41.9	(a)		42.2 (e)
TiO <sub>2</sub>			8	8.15	(a)		8.95 (e)
Al <sub>2</sub> O <sub>3</sub>			12.1	12.49	(a)		12.9 (e)
FeO			17	16.45	(a)		15.7 (e)
MnO	0.22		(c) 0.2	(c) 0.2	(a)		0.22 (e)
MgO			6.8	7.75	(a)		7.54 (e)
CaO			11.2	11.69	(a)		11.4 (e)
Na <sub>2</sub> O			0.47	(c) 0.48	(a)		0.52 (e)
K <sub>2</sub> O	0.19	(b) 0.17	(c)		0.21 (a)		0.17 (e)
P <sub>2</sub> O <sub>5</sub>					0.13		0.2 (e)
S %							
<i>sum</i>							
Sc ppm		66	(c) 62.7	(c)			
V			67	(c)			
Cr		2160	(c) 1950	(c) 1984	(a)		
Co		35	(c) 32.2	(c)	34.8	(d)	
Ni		214	(c)				
Cu		11.1	(c)		9.2	(d)	
Zn		30.2	(c)		28.6	(d)	
Ga		5.9	(c)		5.85	(d)	
Ge ppb					350	(d)	
As							
Se		1.6	(c)				
Rb	3.95	(b) 4.16	(c)		4.15	(d)	
Sr	167	(b) 190	(c)				
Y							
Zr	366	(b)	240	(c)			
Nb							
Mo							
Ru							
Rh							
Pd ppb					13	(d)	
Ag ppb		16	(c)		24	(d)	
Cd ppb					78	(d)	
In ppb		180	(c)		96	(d) 60	(d)
Sn ppb							
Sb ppb		8.8	(c)		72	(d)	
Te ppb					0.128	(d)	
Cs ppm		0.124	(c)				
Ba	206	(b) 167	(c) 200	(c)			
La	19.5	(b) 20.2	22	(c) 17.3	(c)		
Ce	54.3	(b) 56	57.4	(c) 38.1	(c)		
Pr							
Nd	42.5	(b) 41	39	(c)			
Sm	14.6	(b) 14.8	15.1	(c) 13.2	(c)		
Eu	1.82	(b) 1.95	1.95	(c) 1.91	(c)		
Gd	20.6	(b) 20	19.7	(c)			
Tb		3.5	3.44	(c) 3.8	(c)		
Dy	22.9	(b) 25	24.9	(c)			
Ho				4.6	(c)		
Er	13.5	(b) 14	14	(c)			
Tm							
Yb	12.3	(b) 12.5	12.4	(c) 15.2	(c)		
Lu		2.1	2	(c) 1.9	(c)		
Hf		11.7		(c) 14.5	(c)		
Ta				1.9	(c)		
W ppb							
Re ppb							
Os ppb							
Ir ppb					6.88	(d) 10.4	(d)
Pt ppb							
Au ppb		2.5	(c)		2.66	(d) 1.8	(d)
Th ppm	2.58	(b)					
U ppm	0.67	(b)		0.69 (c)			

technique: (a) XRF, (b) IDMS, (c) INAA, (d) RNAA, (e) semi-micro. chem.

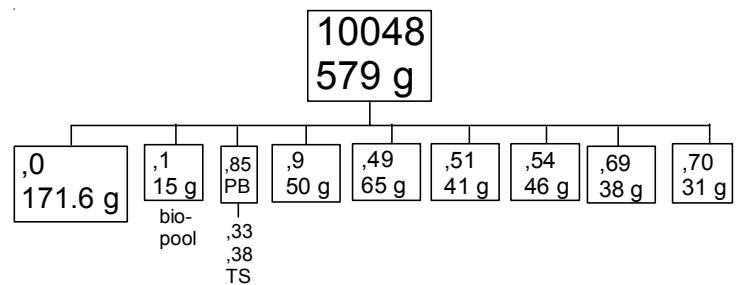


Figure 8: Display sample 10048,51 (no longer used). S74-24907



Figure 9: Photo of 10048,9.

## References for 10048

- Adams J.B. and McCord T.B. (1970) Remote sensing of lunar surface mineralogy. Implications from visible and near-infrared reflectivity of Apollo 11 samples. *Proc. Apollo 11 Lunar Sci. Conf.* 1937-1946.
- Brecher A. (1976a) Textural remanence: A new model of lunar rock magnetism. *Earth Planet. Sci. Lett.* **29**, 131-145.
- Cisowski S.M., Collinson D.W., Runcom S.K., Stephenson A. and Fuller M. (1983) A review of lunar paleointensity data and implications for the origin of lunar magnetism. *Proc. 13<sup>th</sup> Lunar Planet. Sci. Conf.* A691-A704.
- Doell R.R. and Gromme C.S. (1970) Survey of magnetic properties of Apollo 11 samples at the Lunar Receiving Laboratory. *Proc. Apollo 11 Lunar Sci. Conf.* 2093-2096.
- Dunn J.R. and Fuller M. (1972) On the remanent magnetization of lunar samples with special reference to 10048,55 and 14053,48. *Proc. 3<sup>rd</sup> Lunar Sci. Conf.* 2363-2386.
- Filleux C., Spear R.H., Tombrello T.A. and Burnett D.S. (1978a) Direct measurement of surface carbon concentrations for lunar soil breccias. *Proc. 9<sup>th</sup> Lunar Planet. Sci. Conf.* 1599-1617.
- Fruland R.M. (1983) Regolith Breccia Workbook. Curatorial Branch Publication # 66. JSC 19045.
- Fuller M.D. (1974) Lunar magnetism. *Rev. Geophys. Space Phys.* **12**, 23-70.
- Funkhauser J.G., Schaeffer O.A., Bogard D.D. and Zahringer J. (1970) Gas analysis of the lunar surface. *Proc. Apollo 11 Lunar Sci. Conf.* 1111-1116.
- Funkhauser J.G., Jessberger E., Muller O. and Zahringer J. (1971) Active and inert gasses in Apollo 12 and 11 samples released by crushing at room temperature and heating at low temperature. *Proc. 2<sup>nd</sup> Lunar Sci. Conf.* 1381-1396.
- Ganapathy R., Keays R.R., Laul J.C. and Anders E. (1970) Trace elements in Apollo 11 lunar rocks: Implications for meteorite influx and origin of moon. *Proc. Apollo 11 Lunar Sci. Conf.* 1117-1142.
- Goles G., Randle K., Osawa M., Schmitt R.A., Wakita H., Ehmann W.D. and Morgan J.W. (1970) Elemental abundances by instrumental activation analyses in chips from 27 lunar rocks. *Proc. Apollo 11 Lunar Sci. Conf.* 1165-1176.
- Haskin L.A., Allen R.O., Helmke P.A., Paster T.P., Anderson M.R., Korotev R.L. and Zweifel K.A. (1970) Rare earths and other trace elements in Apollo 11 lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.* 1213-1231.
- Hintenberger H., Schultz L. and Weber H.W. (1975a) A comparison of noble gases in lunar fines and soil breccias: Implications for the origin of soil breccias. *Proc. 6<sup>th</sup> Lunar Sci. Conf.* 2261-2270.
- Kramer F.E., Tweddell D.B. and Walton W.J.A. (1977) Apollo 11 Lunar Sample Information Catalogue (revised). Curator's Office, JSC 12522
- Larochelle A. and Schwarz E.J. (1970) Magnetic properties of Apollo 11 sample 10048,22. *Proc. Apollo 11 Lunar Sci. Conf.* 2305-2308.
- Mason B., Fredricksson K., Henderson P., Jarosewich E., Melson W., Towe K. and White J.S. (1970) Mineralogy and petrology of lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.* 655-660.
- McKay D.S., Greenwood W.R. and Morrison D.A. (1970) Origin of small lunar particles and breccias from the Apollo 11 site. *Proc. Apollo 11 Lunar Sci. Conf.* 673-693.
- McKay D.S. and Morrison D.A. (1971) Lunar breccias. *J. Geophys. Res.* **76**, 5658-5669.
- Nagata T., Fisher R.M. and Schwerer F.C. (1972) Lunar rock magnetism. *The Moon* **4**, 160-186.
- Nagata T., Fisher R.M., Schwerer F.C., Fuller M.D. and Dunn J.R. (1971) Magnetic properties and remanent magnetism of Apollo 12 lunar materials and Apollo 11 lunar microbreccia. *Proc. 2<sup>nd</sup> Lunar Sci. Conf.* 2461-2476.
- Phinney W.C., McKay D.S., Simonds C.H. and Warner J.L. (1976a) Lithification of vitric- and elastic-matrix breccias: SEM photography. *Proc. 7<sup>th</sup> Lunar Sci. Conf.* 2469-2492.
- Rhodes J.M. and Blanchard D.P. (1981) Apollo 11 breccias and soils: Aluminous mare basalts or multi-component mixtures? *Proc. 12<sup>th</sup> Lunar Planet. Sci. Conf.* 607-620.

Rose H.J., Cuttitta F., Dwornik E.J., Carron M.K., Christian R.P., Lindsay J.R., Ligon D.T. and Larson R.R. (1970b) Semimicro X-ray fluorescence analysis of lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.* 1493-1497.

Schwerer F.C., Huffman G.P., Fisher R.M. and Nagata T. (1972) Electrical conductivity and Mossbauer study of Apollo lunar samples. *Proc. 3<sup>rd</sup> Lunar Sci. Conf.* 3173-3185.

Schwerer F.C., Huffman G.P., Fisher R.M. and Nagata T. (1973) Electrical conductivity of lunar surface rocks at elevated temperatures. *Proc. 4<sup>th</sup> Lunar Sci. Conf.* 3151-3166.

Simon S.B., Papike J.J. and Shearer C.K. (1984) Petrology of Apollo 11 regolith breccias. *Proc. 15<sup>th</sup> Lunar Planet. Sci. Conf.* in *J. Geophys. Res.* **89**, C109-132.

Thiemens M.H. and Clayton R.N. (1980) Ancient solar wind in lunar microbreccias. *Earth Planet. Sci. Lett.* **47**, 34-42.

Wasson J.T. and Baedecker P.A. (1970) Ga, Ge, In, Ir, and Au in lunar terrestrial and meteoritic basalts. *Proc. Apollo 11 Lunar Sci. Conf.* 1741-1750.

Wiesmann H. and Hubbard N.J. (1975) A compilation of the Lunar Sample Data Generated by the Gast, Nyquist and Hubbard Lunar Sample PI-Ships. Unpublished. JSC